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Wisconsin

REPORT

OF THE

MINING : INDUSTRIES

OF THE

STATE OF WISCONSIN,

AS EXHIBITED AT THE

World's Columbian Exposition,

CHICAGO, 1893.

SHULLSBURG, WISCONSIN:
T. H. McELROY & SON, PRINTERS.
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Hon. John H. Savage,
Chairman Mining Committee,
State Board World's Fair Commissioners.

Dear Sir:—Pursuant to your instructions, I have compiled and herewith submit to you a report on the mining industries of the state of Wisconsin, together with a brief geological report upon the various mining districts.

It has been the intention to compile this report so that it may be of value to the commercial world; to that end I have omitted all matter that could be considered as purely scientific.

I have the honor to remain,
Yours very respectfully,
FRED C. RICHMOND, M. E.

9025

LEAD AND ZINC.

The Lead ores produced in Wisconsin are used almost exclusively by the silver bullion refineries located at Aurora and Chicago, Ill., and Pittsburg, Penn. Their purity as a lead ore ranks at the head; it is no uncommon occurrence to receive furance returns of 89 per cent. metallic lead.

Galenite:—Composition, lead 86.6 per. cent., sulphur 13.4 per. cent.

The zinc ores are of two classes, first Smithsonite or carbonate of zinc, locally known as "dry-bone," composition, carbonic acid. 35.18 per cent., oxide of zinc 64.82 per. cent., is used almost exclusively in the manufacture of Zinc Oxide or what is known to commerce as Zinc White. Second. Sphalerite or Zinc Blende, locally known as "black-jack," composition, zinc 67 per cent., sulphur 33 per. cent. This ore is used exclusively for the manufacture of "Spelter" or metallic Zinc.

The advance in the output of lead and zinc ores as noted for the past three years, has been caused entirely by the introduction of foreign capital and by the use of the latest known methods in both mining and concentration.

Wisconsin as a zinc producing state is but in its infancy. Until within the last three years the mining was of the most primitive character. A machine drill or a hoisting engine was a thing unknown. It was the practice for four or five miners to form a party and with an outfit of tools consisting of a few drills, hammers, picks and shovels, and a hand windlass to start them in their mining operations, they would proceed to prospect for ore. If they were fortunate enough to make a discovery within a few feet of the surface they would develope their find, but if on the contrary they struck water before striking ore they would abandon their prospect hole no matter how favorable the indications were. Their manner of concentration was even more crude than in their mining. As the ore was hoisted to the surface it was thrown into a rough trough through which a heavy stream of water was run. This served to wash off the clay and earthy matter from the ore. From

the trough the ore was passed over a screen of a three-quarter inch mesh, the ore that stayed upon top of the screen was then passed to a table where it was hand-picked by boys. All chats from the table (pieces of ore attached to rock) and the fine ore that had passed through the sieve were then wheeled out onto the dump and thrown away, in this way the miners were tossing at least 33⅓ per cent. of the ore that they mined.

But with the advent of superior mining knowledge and capital the method of mining and concentration has advanced in the short pace of three years so that it now compares favorably with any mining section of the United States. The larger mines are thoroughly equipped with air drills, steam pumps and hoisting works. The concentration plants are equipped with the latest machinery manufactured. A description of one concentrating plant will describe them all. The ore as it comes from the mine is first passed through a Blake crusher and there crushed to about the size of an English walnut; from the crusher it passes by gravity to a set of Cornish Rolls where it is crushed so that the largest particles will pass through a 10 M. M. screen. From the roll pit it is taken by an eleyator to the top of the mill and discharged into revolving screens. Here it is subdivided into five sizes—namely, 1½, 2½, 5, 7½, and 10 M. M., the last four sizes pass by gravity to 4 compartment jigs and the first size to a 2 compartment classifier, the ore from the bottom discharges of which pass to jigs and the overflow to Ritinger or round tables. Should the concentrates carry more than 5 per cent. of iron pyrites the ore is sent to a roasting furnace and given a light roast. This serves to convert the iron pyrites from a sulphuret to an oxide of iron and very materially lessening its specific gravity, the ore is then passed through the process of concentration again and relieved of the oxide of iron.

Occurrence:—The rocks of the Lead and Zinc district of Wisconsin are designated geologically as the upper magnesian lime stone of which the Galena and the Trenton lime-stone are the ore bearing stratas.

The lead and zinc district is composed of the counties of Iowa, Lafayette and Grant, bounded on the west by the Mississippi river, and on the south by the Illinois state line. The ore formation in the Galena limestone is very erratic, the ore forming in gash veins, chimneys and pockets, but in the Trenton limestone it is more regular, making in pitches and blanket sheets. The general trend is east and west, slightly southeasterly. Unlike most mining regions, this district bears no evidence of any sudden disturbances or violent action of physical forces. The effect produced by igneous and eruptive agencies are wanting. Faults and dislocations of strata are seldom found. The writer knows of but two "faults" in the entire region, one at the Stopline mine six miles east of Shullsburg, Lafayette county, and the other at the Hempstead mine in the same city and county. The general irregularities are slight upheavals, or bending of the strata (and these never of great extent) producing changes of but a few feet from the normal dip. Between the geological condition and the general contour of the country, there is no direct co-relation. The Trenton limestone is subdivided into the blue and buff limestone. The blue limestone is remarkable as being the purest limestone in the district, and the nearest approach to the Trenton limestone of the eastern states, both in its lithological and its paleontological characteristics. A very noticeable feature is its marked division into two parts

one very heavy bedded, in layers of two or three feet thick, known as the glass rock, which constitutes the lower half; and the other thin bedded, in layers of two or three inches, graduating sometimes without much change into the thin bedded galena limestone above. It is at this point that the stratum of carboniferous shale (locally known as oil-rock) occurs, which is the line of demarkation between the blue and galena limestones, and as such, is an unfailing guide. It varies very much in thickness, attaining its greatest in the vicinity of Shullsburg, Lafayette County.

The Galena Limestone is almost always invariably a very compact, hard crystalline rock, of a yellowish gray color, with numerous small cavities sometimes filled with a softer material, and sometimes lined with small crystals of calcite. The upper portion is usually thick bedded and free from flints, the layers being fromone to four feet thick, while the lower portion almost invariably consists of several feet of layers from one to two inches thick.

The Galena Limestone is in many localities successfully quarried as a building stone, for foundations, or any work where beauty of finish is not the chief object, it is a good and durable stone.

The organic remains of the Galena Limestone are quite abundant, but do not exist in such profusion as in the blue limestone.

The following section will give a good general idea of the geological formation of this district:

Galena Limestone	*ft.*	*in.*
Soil and loose rock	2	
Yellowish, hard, compact dolomite	from 75 to 100	
Thin layers two or four inches thick	5	
Carboniferous Shale		10
Blue Limestone		
Thin bedded, verp fossiliferous limestone, in layers from two to five inches thick	3	6
Heavy bedded, dark blue limestone, very hard and compact unfossiliferous except in the shaley partings between the beds	12	
Buff Limestone.		
Heavy bedd d, light blue limestone, weathering to buff on exposure; beds from four to six feet thick, contains but few fessils	32	
Thin bedded, fossiliferous limestone similiar to proceeding	13	
Unexplored	10	

The total amount of lead ore produced in Wisconsin, also the total amount of Zinc ore of both smithsonite and sphalerite for for the year ending December 31st, 1890, were as follows:

	lbs.
Lead	8,543,000
Smithsonite	28,258,000
Sphalerite	32,335,000
For the year ending December 31st, 1891.	
Lead	8,750,000
Smithsonite	30,223,000
Sphalerite	33,825,000
For the year ending December 31st, 1892	
Lead	10,111,000
Smithsonite	42,137 000
Sphalerite	36,102,000

IRON.

The iron ores produced in Wisconsin are used mainly in the manufacture of pig metal, and to a limited extent in wrought iron in forges, bloomaries or other direct processes; there probably is not more than four or five per cent. of the iron ore mined in this state that is used for other purposes than those mentioned above. In this report when mention is made as to the amount of ore mined it is meant the actual amount taken from the ground, during the period covered by this report.

When mention is made of the amount of ore shipped it is meant to cover all the ore delivered from the mines, either from the mine direct, the stock pile, or the ore docks to the consumer, therefore it does not necessarily follow that the totals in the amounts mined and shipped will correspond, as it is a practice of the mine owners to constantly keep a large supply of ore on hand, either in the stock piles at the mines or in the ore pockets at the lake ports, and these reserves are constantly increasing or decreasing according to the demands of the consumer.

The iron ores of the state are divided into two classes:

First, RED HEMATITE, being all anhydrous, although known by various names such as red hematite, specular, micaceous, fossil, slate, iron ore, martite, blue hematite, &c.

Second, BROWN HEMATITE, including the varieties of hydrated sesquioxide of iron, and recognized as lemonite, gothite, turgite, bog ores, pipe ores, &c.

The total amount of iron ores produced in Wisconsin in 1891 was 589,481 long tons. The red hematites of which class 527,705 long tons or 89.52 per cent. of the state's total product gave it fourth rank with 5.66 per cent. of the total red hematite output of the nation. Of the total for the state 61,776 long tons or 10.48 per cent. were taken from the brown hematite mines in which class Wisconsin occupied eighth place, with 2.24 per cent. of the total for the United States. The advance in Wisconsin is due to the increased output of mines on the Menominee Range and the opening of new mines on the Gogebic Range.

Occurrence:—The rocks of the iron district of Wisconsin are designated geologically as either Laurentian or Huronian, the latter being the ore-bearing series, the Laurentian rocks are granatic, passing into gneiss and

mica-schists, the latter being formed from the decomposition of the granite. They are feldspathic, siliceous, micaceous, or they are course or fine, according to the predominating elements that enter into their composition, or whether the rocks of which they were made up were ground into mud or gravel. The forces recognized as chiefly instrumental in the rock building of this region are igneous, aqueous, chemical and mechanical. These agencies destroyed the Laurentian, and with the materials thus derived built up the schists, jaspilites, quartzites, green stone, &c., which form the Huronian or iron bearing series of this state.

The Gogebic range lies partly in Michigan and partly in Wisconsin, crossing the river Montreal which forms the boundry line between the two states. The ore formation is the most regular of any in the northern iron district; here the rocks of the iron and copper series come together and run parallel with each other, the traps becoming like the green stone of the Marquette range in Michigan. The general trend is east and west, slightly southwesterly, the ore occurring in the jaspery ferruginous schists lying on or not far from a broad belt of fragmental quartzite, which is one of the most marked features of the ore formation, this belt acting as a guide in the matter of exploration. In this range the quartzite, which was the hanging wall in the Marquette range, becomes the foot wall, the hanging wall being one of the variety of schists or iron slates belong with the ore.

The foot wall occasionally becomes decomposed, but is generally hard and firm. In nearly all the mines the ore is cut by dikes, and this in the early history of the range was so prominent that it was generally considered as indicating two distinct veins of ore.

The principal iron mines of the state are found on the Gogebic iron range, and in the vicinity of Florence on the Menominee Range. Some red hematite is also mined in the eastern central portion of the state and brown hematite in the western central section. The possible advance in the manufacture of steel by the Basic method promises in the future a liberal supply of red hematite ore, locally termed "flaxseed" ore, which abounds about fifty miles northwest of Milwaukee. The special adaptability of this ore for the process named, its convenience to existing blast furnaces, and the low cost of mining, combining to offer inducements for its use, notwithstanding its comparatively low pecentage of iron.

It is also probable that the extensive deposits of brown hematite within convenient reach of the Mississippi river, may encourage the development of industries to produce pig iron for foundry use.

Transportation of Iron Ores:—Much of the Iron ores have to be transported long distances to reach points of consumption, an essential of such rehandling and transporting is that it should be done in the least possible time and at small expense in order to enable the ores to compete with others, which although not so rich, are found near the blast furnaces. As the principal cost of rehandling is for labor, large amounts of money have been expended by different railroad companies for docks and cars built specially for the purpose, so as to bring this item to the lowest point practicable, and also make it possible to handle quantities of material which would have been impossible if done by manual labor. It is now no unusual thing for ore to be taken

from the mine in "skips," automatically dumped into specially constructed railroad cars or into ore bins from which it can be discharged into cars, then hauled in these cars to the ore docks, where the drop bottoms of the cars are opened and the ore falls into the pockets from which it is run into the hold of the vessel, and in this whole process the only labor necessary is to open the doors of the bins or the bottoms of the railroad cars. When the material is deposited in the pockets in the ore docks, the spouts of the pockets are lowered into the holds of the vessels, the doors leading to the spouts are opened, and the ore slides into the vessel's hold, being assisted, if necessary, by poking with long poles. The extraordinary development of the Gogebic Iron range in Michigan and Wisconsin and of the Vermillion Iron range in Minnesota caused the erection of shipping docks for the former at Ashland, Wisconsin, and for the latter at Two Harbors, Minnesota, both ports making their first shipments in 1884. Ashland, however, soon outstripped its rival and in 1891 ranked second as a shipping point, with 1,261,658 long tons as its output, and in 1892 shipped 2,221,241 long tons nearly 100 per cent. increase in twelve months.

Shipping Docks:—The ore shipping docks consist of a wooden structure built on piles, are reached by long or short approaches, depending upon the nature of the ground, and the depth of the water. On top the docks are from 38 ft. to 51 ft. 10 in. above the ordinary water level, and wide enough to accommodate from two to five lines of railroad track. In the latest construction the gauge between tracks is the same as between the two rails forming one track, thus making the entire top of the dock practically an opening into the various pockets. The ore docks have from fifty to three-hundred pockets holding from 80 to 170 tons of ore each.

The pockets are sheathed with sheet iron and slope downward toward the water side of the dock. At the bottom of each pocket is a door which is controlled from the top of the dock. When it is desired to load a vessel, plate iron chutes, usually semicircular in form, are lowered into the hatches of the boat, the doors which connect these chutes to the respective pockets are raised, and the ore discharges itself into the hold of the vessel. This occupies a very short time, if a sufficient number of bins can be discharged at once, and a few instances of quick dispatch may be mentioned. The steamer Massachusetts was loaded with 1,659 long tons of iron ore in forty-five minutes; the Maryland was loaded with 3,027 long tons in three hours; the Manchester was loaded with 2,502 long tons in two hours; the Manhatten was loaded with 1,859 long tons in forty-five minutes. In this last case just one hour elapsed between the arrival of the boat at the dock and its departure. The record for most rapid loading is that of 980 tons which was run into the steamer Frontnac in four and three quarter minutes.

The following table shows the location, principal dimensions, capacity, &c, of the iron ore shipping docks erected at the Lake ports of Wisconsin :

LOCATION.	Height of Dock	Length of Dock.	Number of Pockets.	Total Capacity	Number of Railroad Tracks	Cost.
	ft.	ft.		long ton		
Ashland Wis. No. 1	40	1404	234	23000	4	
Ashland, Wis. No. 2	45	1404	234	27000	3	$483000
Ashland, Wis. No 3	46	1404	234	28250	3	$256000

The above docks have an annual capacity of 6,000,000 long tons. The ore from the Gogebic range assays from 60 to 64.50 per cent Iron.

Wisconsin Iron Furnaces.

Name of Furnace. (Charcoal)	Location.	No. Stacks and Size.	Date Blown in	Ore Used.	Annual Capacity In tons.
Florence Furnace	Florence,	1,40x8	Nov. 13 '81	Menomine hema't'e	6000
Fond du Lac Furnace	Fond du Lac.	1,52x10½	1883		15000
Hinkle Furnace	Ashland,	1,60x12	March. 1888	Gogebic hematite	45000
Minneapolis Furnace	Bik R'v'ls,	1,55x11	Aug. 1886	Gogebic hematite.	25000
National Furnace	Depere	1,45x10½	Feb. 1870	Lake Ores.	22000
Sauk Furnace	Ironton	1,50x8½	1857	Brown hematite	3500
(Coke.)					
Ill. Steel Company	Bay View	2,60x15½	1870	Lake Ores,	110000
Mayville Furnace	Mayville	1,67x14	1887	Local & Lake ores	57000
Minerve Furnace	Milwaukee	1,56x14½	1873	Lake Ores.	30000
West Superior Iron and Steel Co.	W. Superior	1,80x18			

Annual Capacity Wisconsin Iron Mines, Gogebic Range.

Name	1891.	1892.	Increase.	Decrease
Carey	121,186	106,492		14,694
Germania	32,000	4,283		27,717
Iron Belt	1,506	161,635	160,129	
Montreal	70,105	58,728		11,379
Sec. 33 Bessemer	38,576	14,681		23,695
Hennepin	15,759			15,759
Superior	10,710	14,277	3,567	
Ontario		6,711	6,711	
Windsor		55,241	55,241	

Net Increase 160,201

Analysis of the Gogebic Iron Ores.

Name.	Iron.	Phosphorous.	Silica.	Mang'nese.	Alumina	Magnesia	Lime.	Sulphur.
Carey	58.84	0.052	5.35					
Germania	59.19	0.[illegible]						
Iron Belt	62.38	0.042	6.36		2.44			0.065
Montreal	64.32	0.050						
Sec. 33	64.62	0.046						
Hennepin	65.45	0.048	3.53	0.02	0.31	0.02	0.02	0.032
Windsor	62.00	0.051	6.30	0.82	3.45	0.31	4.46	0.025

SANDSTONE.

The Potsdam sandstone of the LOWER SILURIAN group outcrops in the eastern part of the state, it has a thickness ranging from 0 to 1000 ft.

The upper surface of this formation is essentially uniform and nearly horizontal, and is overlaid by the LOWER MAGNESIAN limestone.

General Character:—The rock is chiefly composed of cemented grains of silicious sand. The grains appear spherical, but upon examination under the microscope, they are seen to be more or less angular and irregular, and show that they have been formed from small fragments, and in some cases, minute crystals of quartz, which have been worn by friction to their present form.

Very commonly, the grains of sand are firmly cemented calcareous or ferruginous matter. In many cases this is not so much the filling of the space between the grains as it is a coating of the grains themselves by which they are firmly bound together. It is this variety that furnishes the most desirable building material. This article will treat only with the sand stones used for building purposes, which are as follows:—Madison Sandstone and Mendota Limestone. The Madison Sandstone occurs in the vicinity of the capital of the state and is extensively used as a building stone. It is course grained, thick bedded, compact, but soft, slightly calcerious and light colored.

The Mendota Limestone occurs near Lake Mendota. The term limestone is applicable, however, only in a qualified sense. It consists really of a group of alternating strata of arenaceous magnesian limestone sandy calcerious shales, and shaley and calcerious sandstones. It resists erosion to a greater degree than the sandstone above and below.

The shales are variegated with yellow, red and purple

LAKE SUPERIOR SANDSTONE. By this term I refer to the redish, aluminous, horizontal sandstones which border on the lake shore in Bayfield County and extend as far south in Douglas County as the northern limit of the copper range. This sandstone is chiefly composed of small, rounded

and sometimes somewhat angular grains of quartz, cemented by a ferruginous matrix. Most of the grains are coated with peroxide of iron, which imparts a characteristic redish color to the stone. An analysis of the Prentice Brownstone quarry which is a fair sample of the district is as follows:

Silica, 91.40 per cent., Farris Oxide, 2 per cent., Lumia, 3.53 per cent., Lime, .25 per cent., Potash, 2.36 per cent., Soda, .14 per cent., Moisture, .05 per cent.

The composition shows that the sandstone must at least have had its origin in the highly aluminous and ferruginous crystalline Keweenawan rocks.

This sandstone is used very extensively as a building stone having great compression strength and fire proofing qualities. The product of the principal quarries for the years 1889, 1890 & 1891 are as follows.

Quarries	1889.	1890.	1891.	
Prentice Brownstone Company	383,887	623,334	650,000	Cubic Feet.
Ashland Brownstone Company	115,000	127,542	250,000	
Hartley Brothers	98,542	107,421	120,000	
Smith & Babcock	105,000	125,438	170,000	
E. D. Pike	102,000	77,473	105,000	
Basswood Island		40,000		
Lake Superior Brownstone Co.			100,000	
Excelsior Quarries			250,000	
	804,429	1,101,203	1,645,000	

GRANITE.

Archaean Formations. The district under consideration is occupied almost exclusively by Pleozoic formations. The Archaean rocks form the great sloping floor upon which these latter deposits rest, and rise to the surface along their northern border. But the Archaean surface is very irregular, and here and there knobs rise through the superimposed formations, giving rise to isolated hills of quartzite, porphyry, and granite in the form of islands as it were. It is to these protruding, but not instrusive, masses that our attention will be chiefly confined.

The Mukwa Granite.

This isolated outlier is found in the town of Mukwa, Waupaca County, and lies nearest the Archaean area. It consists of three large and as many small, rounded, elongated, domelike outliers, arranged nearly in a line trending W. 35 deg. N., and rising near the center to a height of nearly 70 feet.

The rock consists chiefly of red fieldspar, with which is associated a less quantity of quartz and a small and varying amount of a dark mineral, which is not seen in a distinct crystalline form, but which seems to be an aggregation of minute blended blades of plottite.

The rock is very little affected by weathering and affords an excellent building material.

The Berlin Porphyry.

At Berlin, thirty miles south of the above, is found an outstanding Archaean mass consisting of three large elongated domes bearing northeast. The rock is composed essentially of small crystals of orphoclase feldspar disseminated through a peculiar cryptocrystalline base of felsite and quartz forming a quartz porphyry. The crystals of feldspar are usually grayish before weathering, becoming reddish afterwards.

The base in its unweathered state very much resembles quartzite, and is of dark grayish cast with a very slight reddish tinge, so modified by its translucency as to give to the whole what may be called a water hue. The effect of weathering is marked and peculiar. The color changes to a light reddish, pinkish or grayish white and occasionally to a bright red, while the mass becomes opaque and finally granular.

The Quartz Porphyry of Pine Bluff.

Seventeen miles south of Berlin there rises out of the flood plane of the Grand river a conspicuous mass of quartz porphyry known as Pine Bluff, it ascends by steep, and even precipitous activities to a height of one hundred feet. The rock consists of white, gray and flesh colored crystals, of orthoclase, and of glassy feldspar, set in a very hard, gray on black quartz-felsite basis. The crystals of feldspar vary in size from three tenths of an inch in length, downwards, but are rendered conspicuous by contrast of color. The rock is susceptible of a very high and beautiful polish, but is wrought with difficulty on account of its hardness.

The Quartz Porphyry of Marquette.

Near Marquette, a little more than twelve miles west of Pine Bluff, very similar quartz porphyrys display themselves in more considerable force, constituting a range of prominent hills. A portion of the rock is precisely identical in character with that of Pine Bluff, and the greater mass is but an unimportant variation from it, but certain portions depart from the porphyritic character, and become almost, or entirely, crypto-crystalline. One variety of this kind very closely resembles the more homogenous of the red Huronian quartzites, and in another is a compact close-textured rock, usually of dark color, but sometimes greenish.

Though the Berlin porphyry differs from that of Pine Bluff and of Marquette in the absence of glassy feldspar, yet the close lithological alliance is very evident, and they doubtless all belong to the same group of the Archaean series.

All of these masses present the rounded contour of glaciated surfaces, and still bear the glacial grooyings, and, in some cases even remnant polished spots, and from all these, trains of porphyry boulders stretch away in the direction of the striae.

CEMENT AND CEMENT ROCK.

The uppermost and newest of the indurated formations of Wisconsin, and the only representative of the Devonian age, is the Hamilton cement rock, near Milwaukee. It occupies a limited area, lying adjacent to the Lake, immediately north of the city, and rests in part upon a shaley limestone, and apparently upon the Niagara limestone in other portions.

In general lithological characteristics, it consists of a blueish-gray or ash-colored impure dolomite, which weathers, upon exposure, to a yellowish or buff color, owing to the oxidation of the iron which constitutes one of its ingredients. The beds are usually thick with the exceptions of some portions, which are somewhat shaley.

The chemical composition of the typical portion is very fully indicated by the accompanying table of analysis of cement rocks

Analysis of Cement Rocks.

Kind of Rock.	Carbonate of Lime.	Carbonate of Magnesia.	Total Carbonate.	Silicia.	Alumina	Oxide of Iron, &c.	Total Silica Alumina, Iron, &c.
Milwaukee average	45.11	30.89	76 00	16.61	4.09	3 25	24.00
Resendale, N. Y	46.09	17.76	63.76	27.70	2.34	6.20	36.24
Utica, N. Y	50.42	18.67	69.09	21.60	5.27	4.04	30.91
Utica, N. Y	58.84	15.38	64.22	25.20	6.16	4.40	35.76
Akron, Ohio	35.60	19.26	54.86	33.80	3.96	7.38	45.14
Sandusky, Ohio	40.54	17.98	58.52	19.66	3.14	5.36	40.26
Points aux Roche, N. Y	53.30	22.60	75.90	20.07	1.70	1.70	23.44
Cumberland, Md	41.80	4.10	45 90	21.74	16.74	15.30	56.76
English	65.70	0.50	66.20	18.00	6.00	8.80	33.40
Bologne, France	61.60	0.00	61 60	15.00	4.80	15.60	35.40
Vassy, France	65.80	1.50	65 30	14,00	5.70	15,00	34.70
Theil, France	60.00	1.32	61.32	18.20	1.20	11.28	30.68

The following table shows the tensile strength in pounds per square inch of mortars of clear cement, seven days old the last six in water; also of mortars composed of equal weights of cement and sand at ninety days, the last eighty-nine in water.

Kind of Cement.	Tensile strength, in pounds per square inch, of mortars composed of	
	Clear Cement, seven days old.	Equal weights of Cement and sand ninety days old.
Commercial Cements—		
No. 1		
2	95	194
3	77	185
4	38	152½
5	97	270
7	107½	195
8	133½	204½
9	44	
10	36	140
11	94½	182¾
12	95	280
13	98¾	149
14	98	156
15	70½	196¾
16	101	166
Milwaukee Cement	98	206¾
	96	290

Breaking Strength of Cement Mortars.

Kind of Cement.	Whitmore.	
	Cement 2 Sand 1	Cement 1 Sand 2
Commercial Cement No. 1	54	23½
Commercial Cement No. 3	59	44½
Commercial Cement No. 4	98½	44½
Commercial Cement No. 7	100	47
Commercial Cement No. 10	59	44¾
Commercial Cement No. 11	107	56½
Milwaukee Cement, Average	124	69

From the above, it will be seen that the average breaking strength of the Milwaukee cement is 16 per cent. higher than the best result obtained from the six commercial samples tested, when the proportions were two of cement to one of sand, and 22 per cent. when the proportions were one of cement to two of sand.

Crushing Strength

In pounds per square inch, of cement mortars, ninety days old, the last eighty-nine in water.

Kind of Cement	Composition of Mortars.						
	Clear Cement.	3 to 1	1 to 1	1 to 2	1 to 3	Aggregate of 1 to 1, 1 to 2 and 1 to 3.	Value.
Commercial.							
No. 1	2775	1930	884	299	128	1311	33
No. 2	2200	1614	794	337	180	1311	33
No. 3	2028	1661	1071	417	233	1721	43
No. 4	3302	2767	1536	802	524	2893	70
No. 5	2983	2150	939	742	472	2153	54
No. 6	3479	3060	1590	895	615	3100	77
No. 7	4742	3475	1737	843	625	3205	80
No. 8	2767	2396	1596	1068	571	3235	80
No. 9	3789	3156	1900	955	586	3441	85
No. 10	3247	2381	2075	1208	750	4030	100
No. 11	5019	3572	2130	1192	681	4003	100
Milwaukee							
A	3705	3691	2340	1596	1083	4919	125
B	3887	3321	2146	1261	1127	4534	114
C	3704	3469	2478	1467	1083	5028	125
B and C mixture	5330	4630	2497	1479	1135	5111	128
Portland			3356	1769	792	5917	148

By an inspection of the above table, it will be seen that the strength of the clear cement, the commercial article No. 7 and 11 surpass the Wisconsin product, but as the admixture of sand is increased, the relative superiority of the latter becomes very conspicuous. It appears that the larger proportion of sand, the greater the relative value of the Milwaukee cement. Since cement is usually used with at least an eqaal amount of sand, the columns in the above table that give proportions of 1 to 1, 1 to 2, and 1 to 3 indicate the practical value of the propucts axamined, and they therefore are combined in the sixth column of the table. The last column gives in a more convenient form the value of the several cements for the proportions indicated, the two best commercial cements being takan as a standard of comparison, and expressed by 100.

It will be observed that the average of the tests of the Wisconsin product, exceed the highest of the commercial articles by 23 per cent. and exceeds the average of eleven, which represent the relative strength of the cement in the Milwakee market, by 54 per cent. The remarkable imported cement, known as Portland, was included in these tests, and the results are given in the table.

Adhesive Strength

Commercial Cement No. 1	39¾
Commercial Cement No. 2	59
Commercial Cement No. 3	46
Commercial Cement No. 4	27⅞
Commercial Cement No. 6	41¾
Commercial Cement No. 7	54½
Commercial Cement No. 8	41¾
Commercial Cement No. 10	66
Commercial Cement No. 11	63½
Average of commercial cements	45½
Average of three products of Milwaukee cement	75½
English Portland	47½

PROCESS OF MANUFACTURE. The companies engaged in the manufacturer of hydraulic cement and their capacity, &c. are as follows:

Milwaukee Cement Company.

Capacity.	No. of Kilns.	Size.	Product 1890.	Product 1891.	Product 1892.
4000 bbls. daily.	40	36ftx12ft.	450000 bbls	475000 bbls.	500000 bbls

Cream City Cement Company.

450 bbls daily	4	35x12	70000 bbls.	80000.	110000 bbls.

The cement rock is first broken in the quarry to the size of a cocoanut and smaller, it is then loaded into cars and drawn on an inclined tramway to the top of the kilns, the kilns after being fired up are charged in alternate layers of coal and cement rock, in the proportion of one part coal to four parts of cement rock, it is then burnt or "calcined" for 72 hours, the rock is then discharged from the bottom of the kilns into the crushers which are of the "coffee-mill" pattern, from the crushers it is passed over a 50 mesh screen, that part of the cement which passes through the screen is spouted to the packing room, and that part which is to coarse to pass through the screen is passed to the mill stones where it is ground so that the product will be 90 fine, and is then conveyed and spouted to the packing room where it is packed in bags or barrels as occasion requires. The Milwaukee cement company turn out a carload of cement every twenty minutes, employ from 200 to 300 men and have an annual pay roll of $100,000.